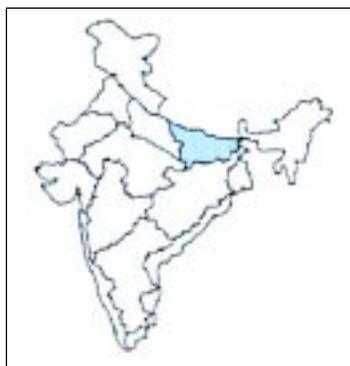


Long-term Strategies and Programmes for Mechanization of Agriculture in Agro Climatic Zone-IV : Middle Gangetic Plains region

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1. NAME OF AGRO CLIMATIC REGION : Middle Gangetic Plains region
2. STATES UNDER THIS REGION : Bihar and Eastern Uttar Pradesh



3. SUB-AGRO CLIMATIC ZONES WITH THEIR CHARACTERIZATION

There are following 6 sub-Agro Climatic Zones in this region, 3 falling in Bihar and 3 in Uttar Pradesh:

Bihar

- (i) North West Alluvial Plain Zone
- (ii) North East Alluvial Plain Zone
- (iii) South Bihar Alluvial Plain Zone

Uttar Pradesh

- (i) North Eastern Plain Zone
- (ii) Eastern Plain Zone
- (iii) Vindhyan Zone

3.1 North West Alluvial Plains Zone of Bihar

The northern Bihar Plains include 11 districts of Bihar. These are Paschim Champaran, Purbi Champaran, Gopalganj, Siwan, Saran, Sitamarhi, Muzzaffarpur, Vaishali, Madhubani, Darbhanga and Samastipur. The sub-zone is at the foot of the Himalaya and receives 1,275 mm of rainfall. The climate is dry to moist sub-humid and the soil type is heavy textured sandy loam to clayey, medium acidic. Over 70% of the land in this sub-zone is arable and about 42% of this is irrigated.

3.2 North East Alluvial Plains Zone of Bihar

Madhepura, Purnia, Katihar, Khagria, Begusarai and Saharsha districts of Bihar constitute this sub-zone. Being at the end of the mid gangetic valley, drainage and management of floods and seasonal rushes is a problem in the region. A little over 60% of the land is cultivated and 44% of this is irrigated. The region receives 1,224 mm of rainfall and the climate is similar to other sub-zones in the Bihar plains-dry to moist sub-humid. Cropping intensity in this zone is high relative to the other sub-zones in the zone, however land productivity is low.

3.3 South Bihar Alluvial Plains Zone of Bihar

The South Bihar Plains cover Bhojpur, Rohtas, Patna, Aurangabad, Jehanabad, Nalanda, Gaya, Nawada, Munger and Bhagalpur districts. The region is well irrigated. Over 75% of the Cropped area is covered by irrigation, which is mostly through a network of canals. However the proportion of net sown area is relatively low at 54% and the cropping intensity is also relatively low at 121%. About 13% of the land is under forest cover.

3.4 North Eastern Plains Zone of Uttar Pradesh

This sub-zone covers the districts of Baharaich,

Gonda, Balrampur, Basti, Gorakhpur, Sidharth Nagar, Maharajgunj, Kushinagar and Deoria. Rainfall is quite high at about 1,210 mm, the climate is moist sub-humid to dry sub-humid. 73% of the land area is cultivated and about half of the cultivated land is irrigated. Tube wells are the major source of irrigation.

3.5 Eastern Plain Zone of Uttar Pradesh

Azamgarh, Mau, Balia, Faizabad, Ghazipur, Jaunpur, Sant Ravidas Nagar and Varanasi districts fall under this sub-zone. Rainfall is adequate with a normal of 1,025 mm. The climate is dry sub-humid to moist sub-humid. Over 70% of the land is cultivated and more than 80% of the cultivated area is irrigated.

3.6 Vindhyan Zone of Uttar Pradesh

Mirzapur and Sonbhadra districts of Uttar Pradesh are the Vindhyan sub-zone of the Middle Gangetic Plain zone. Rainfall is adequate at about 1,134 mm; the climate is similar to the other parts of the eastern plains of Uttar Pradesh. However, the region has a very high forest cover of about 40% of the land. Less than a third of this land is cultivated and only a third of this is irrigated.

4. GENERAL TOPOGRAPHY OF THE ZONE WITH BRIEF HISTORICAL BACKGROUND OF AGRICULTURAL DEVELOPMENT OF THE ZONE

The land topography is of plain land, fairly levelled to very gently sloping with slopes ranging from 0–3%. Soils are deep and water table is high. Shallow tube wells, open wells and tank irrigation are common for supplemental irrigation. Canal irrigation is also available in some parts of this region. Agriculture is the main occupation of the rural people. Land is fertile and can give good yields with proper management. Many of the farmers take two crops a year, and some with assured irrigation also take third crop during summer.

5. OPERATIONAL LAND HOLDING PATTERN BY MAJOR SIZE GROUP

The average operational land holdings in Bihar and Uttar Pradesh during 1995–96 were 0.75 and 0.86 ha respectively against the national average of 1.41 ha. The ratio of marginal, small, semi-medium, medium and large category of farmers were 80.15, 10.78, 6.65, 2.22 and 0.20% respectively in Bihar and 75.43, 14.56, 7.36, 2.47 and 0.18% respectively in Uttar Pradesh. In both the States, about 90% farmers were under marginal and small categories with an overall average between 0.456 and 0.555 ha. Predominance of such small farms poses

serious problems in mechanization and use of costly machinery on individual ownership basis for self-use only is not economically viable.

6. IMPORTANT SOIL TYPES AND CROPS

The soils in this region are alluvium-derived soils mostly khaddar (recent alluvium) and hangar (old alluvium). In some area the soil is highly calcareous. The soils are deep, loamy and high in organic matter content.

Rice, maize, pigeon pea, moong bean crops are common in *kharif* season. In post-rainy (*rabi*) season wheat, lentil, Bengal gram, pea, and sesame and at some places groundnut is grown on residual soil moisture with one or two supplemental irrigation. The important cash crops of the region are sugarcane, potato, tobacco, chillies, turmeric and coriander with supplemental irrigation. Rice-wheat cropping system is more predominant. Amongst the fruit crops mango, guava, litchi, banana and citrus, and amongst the vegetable crops potato. Onion, brinjal, tomato, cauliflower and cabbage are important. Rain fed agriculture with supplemental irrigation is practiced.

The average consumption of fertilizer in 2001–02 in Bihar was 87.39 kg/ha and in Uttar Pradesh 130.44 kg/ha against the national average of 90.12 kg/ha.

7. CLIMATE AND ANNUAL RAINFALL

Hot, wet summer and cool dry winter characterize the climate of the region. The region receives an annual rainfall of 1,050–1,300 mm, 80% of which is received during the months of June to September. The area experiences a small seasonal water deficit of 400–500 mm during February to May. The growing period ranges from 180–210 days in a year. The soil moisture control section (SMCS) either as a whole or in parts remains dry from middle of January till May (about 120–150 cumulative days).

8. POPULATION AND POPULATION DENSITY OF THE ZONE

As per 2001 census, the population density in this region was very high, literacy rate was low and percentage of population below the poverty line was also very high. It was 880/km² in Bihar and 689/km² in Uttar Pradesh as compared to 324/km² at national level. The literacy rate was low, 47.53% in Bihar and 61.03% in UP. The percentage of people below the poverty line was high. It was 42.60% in Bihar and 31.15% in Uttar Pradesh in 1999–2000.

9. BRIEF SCENARIO OF AGRICULTURE SECTOR

Agriculture sector is the backbone of economy of this region. About 89.53% of the total population of Bihar (total of 82.88 million people) and 79.22% of the total population of Uttar Pradesh (total of 166.05 million people) in 2001 was living in rural areas and depending on agriculture and allied sector for their livelihood. Similar pattern exists in region no. IV also. Due to our social structure in which land belonging to a person gets divided into its children, the land holdings are getting smaller and smaller. The average operational holding size, which was 0.83 ha in 1990–91 in Bihar, got reduced to 0.75 ha in 1995–96 and in Uttar Pradesh the average operational holding size got reduced from 0.90 ha to 0.86 ha during the same period. This is going to be reduced further to about 0.50 ha in Bihar and 0.57 in Uttar Pradesh by 2020, unless the Govt. either takes some drastic measures to change the land tenancy rules or create enough jobs in non-agricultural sector to reduce the dependence of people on agriculture from the present levels ranging between 79 to 89% to about 20% or even less as is the case in developed countries.

On one hand the number of people dependent on agriculture for their livelihood is increasing every year, the share of agricultural and allied sector in the State GDP is going down. While it was more than 60% in 1950, it got reduced to about 34% in Bihar and 31.7% in Uttar Pradesh during 2001–02. This is due to the rapid development of industrial and infrastructure sectors on one hand and shifting of agro-processing activities from rural sector to bigger towns due to better availability of electricity and other facilities.

In the rural areas, on an average there are 5 persons in a family. Since the average operational holdings of about 80.14% of the population under marginal and 10.78% in small categories in Bihar were only about 0.34 ha and 1.32 ha respectively in 1995–96 and 75.42% under marginal and 14.56% in small category in Uttar Pradesh during the same year of 1995–96 were 0.39 and 1.41 ha respectively, with overall average of these two categories as 0.456 ha in Bihar and 0.555 ha in Uttar Pradesh. The per capita availability of land in the two combined categories in these two States was only between 0.091 to 0.111 ha. Most of the people below the poverty line in rural areas (about 43% in Bihar and 32% in Uttar Pradesh) belong to these categories of farmers.

Agricultural mechanization is an important input to agriculture for timely farm operations; reducing the cost of operation; maximizing the utilization efficiency of

costly inputs (seeds, fertilizer, plant protection chemicals, water and machinery); improving the quality of produce; reducing drudgery in farm operations; improving the productivity of land & labour and for improving the dignity of labour.

The strategy for mechanization in different regions will be different depending on the conditions and resources of that region. The agricultural mechanization strategy for this region has been suggested keeping in view the land holding pattern, the available resources in that region, the per cent of population depending on agriculture, the important cropping systems being followed in the region, farm power availability and the infrastructural facilities available for promotion of agricultural mechanization and agro-processing programmes in the region.

10. BRIEF SCENARIO OF ANIMAL HUSBANDRY SECTOR

Time series population of livestock and draught animals shows that while the draught animal population in the recent past has started going down, the overall population of livestock has been going up since 1951. The use of animal energy during 1977 to 1992 in Bihar was showing almost a constant use ranging between 211 to 261 animal pair hr/ha while during the same period the use of animal energy in Uttar Pradesh has been declining from 211 animal pair hr/ha in 1977 to about 88 animal pair hr/ha in 1992. This was due to increasing population of tractors in Uttar Pradesh.

Production of Milk, Egg and Wool

The production of Milk, Egg and Wool in 2001–02 in Bihar was 4,068 tonnes, 1,565.60 million numbers and 1,338 tonnes respectively while in Uttar Pradesh, it was 16,506 tonnes, 997.80 million numbers and 2,059 tonnes respectively.

11. BRIEF SCENARIO OF FISHERIES SECTOR

The production of inland fisheries in 2001–02 in Bihar was 2,40,400 tonnes while in Uttar Pradesh, it was 2,25,371 tonnes.

12. IRRIGATED AREA AND SOURCE OF IRRIGATION

About 49.5% area under food grains in Bihar and 64.9% in Uttar Pradesh was irrigated in 2001–02. About 33.5% area in Bihar and 89.5% in Uttar Pradesh under the sugarcane crop was irrigated in 2001–02. The irrigated area under other crops was low. Amongst the sources of irrigation, the area under tube well irrigation was high (58–74%) followed by canal irrigation.

13. INFRASTRUCTURAL FACILITIES AVAILABLE IN THE ZONE

13.1 Metalled Road

The districts falling in Bihar have poor network of roads while the districts falling in eastern Uttar Pradesh have fairly good network of metallic roads. Those villages which are not having metallic roads are connected with the public transport system.

13.2 Rural Electrification

Till November 1996 about 70.8% villages in Bihar and about 77.0% in Uttar Pradesh were electrified. However, they also do not get proper supply due to frequent power cuts. The electricity is available hardly for 4–5 hours in days in Bihar and 8–10 hours in Uttar Pradesh that too the timings are not regular, hence the farmers cannot plan their work properly. They have to necessarily depend on diesel engines for their irrigation, threshing and other stationary jobs.

13.3 Important markets for sale of farm implements and machinery/grain mandies

All big manufacturers of tractors and pump sets have their show rooms/dealers in big towns like Muzzaffarpur, Patna, Samastipur, Darbhanga, Gaya, Bhagalpur in Bihar and Gorakhpur, Faizabad and Varanasi in UP.

Almost in every town there are a few manufacturers making different types of implements and machinery, but there are bigger markets for manufacture and sale of farm machinery located in Muzzaffarpur, Patna, Samastipur, Darbhanga, Gaya, Bhagalpur in Bihar and Gorakhpur, Faizabad and Varanasi in UP.

Specialised equipment is bought from other States. In spite of good manufacturing base for production of different types of agricultural machinery, their availability in many of the districts is not very satisfactory. The quality of implements being manufactured by majority of the manufacturers of the region is not very good and needs improvement.

In this region, almost all the 40 districts have Krishi Upaj Mandies. Districts like Patna, Muzzaffarpur, Darbhanga, Samastipur, Gaya, Bhagalpur, Gorakhpur, Faizabad and Varanasi have big grain mandies. They also have big fruits and vegetable markets.

13.4 Infrastructural facilities available for manufacture of agricultural implements and Machinery

There are a number of manufacturers of farm implements and machinery in this region. Almost in

every town there are a few manufacturers making different types of implements and machinery, but there are bigger markets for manufacture and sale of farm machinery located in Muzzaffarpur, Patna, Samastipur, Darbhanga, Gaya, Bhagalpur in Bihar and Gorakhpur, Faizabad and Varanasi in UP. These manufacturers manufacture animal drawn and tractor drawn equipment like ploughs, harrows, cultivators, seed/seed-cum-fertilizer drills, potato planters, power threshers, tractor trolleys, bullock carts etc. Some of the manufacturers also make manually operated equipment.

Manufacture and sale of farm machinery is mostly in private sector. However Agro Industries Corporations in Uttar Pradesh and Bihar also have their own workshops in this region for the manufacture of limited numbers of simple implements but their activities are at a very low level.

Almost all the manufacturers of tractors, pump sets and plant protection equipment have their dealers located at the district headquarters of big towns.

13.5 Infrastructural facilities available for sale/repair and maintenance of tractors and other machinery in the region

There are very good infrastructural facilities available for sale, repair and maintenance of different types of agricultural machinery, almost in every town. Facilities for specialized jobs like crankshaft grinding, injector pump testing etc are available at district headquarters only.

13.6 Facilities available for extension/training of farmers, artisans/farm women, Entrepreneurs etc.

In this region, there are a number of ICAR Institutes, their Regional Stations, Agricultural Universities and Krishi Vigyan Kendras. Some facilities for training of farmers, farmwomen, mechanics, school dropouts are available in these organisations and at Farmer's Training Centres run by the State Governments. But all these trainings are not at all adequate. Training facilities related to operation, maintenance and repair of different types of agricultural machinery is almost missing/highly inadequate and need to be strengthened substantially as the population of power-operated machinery is increasing at a fast rate.

13.7 Facilities for credit

Credit facilities are available from the Nationalised/Commercial Banks, Regional Rural Banks and Cooperative Banks, whose branches are spread all over the region. Credit is also available from Cooperative Societies and Sugarcane Unions. Credit from these

banks/cooperative societies is available on reduced interest rates for agricultural purposes.

The Government of India introduced the "Kisan Credit Card" scheme during 1998-99, which is now being implemented by 27 commercial banks, 373 district central/State cooperative banks and 196 regional rural banks throughout the country including this region. Till 31st March, 2002 there were 5,56,738 Farmers Credit Card holders in Bihar and 36,63,438 Farmers Credit Card holders in UP.

13.8 Incentives, concessions, subsidies available to farmers/manufacturers of agricultural implements

Subsidies on different types of agricultural machinery are available for different categories of farmers under centrally sponsored scheme. These subsidies are provided to the farmers under the Micro-management scheme of the State Governments.

13.9 Infrastructure for Execution and Monitoring of Agricultural Engineering Extension Programmes

The infrastructure for execution and monitoring of the agricultural engineering programmes in both the States is very poor. There are a few positions of agricultural engineers in the Directorate of Agriculture but those are highly inadequate and practically there is very little activity in this Directorate on front line demonstration, training, promotion and monitoring of agricultural mechanization programmes in the region. The budget allocation for this type of activities is also very meager.

14. Agricultural implements being used by the Farmers

Majority of the farmers are using animal drawn equipment. During the last 10 years, the population of tractors in this region has increased substantially and use of power machinery is now becoming popular. The average annual sale of tractors and power tillers in Bihar during the last 7 years was about 14,000 and 300 respectively while in Uttar Pradesh, it was more than 50,000 tractors and 40 power tillers. Custom hiring of tractors, threshers and other power machinery is becoming popular.

15. SWOT Analysis of Mechanization Programme in the Region

Strengths

1. Land topography is of plain land, fairly levelled.

2. The soils are light, alluvium—derived soils mostly khaddar (recent alluvium) and hanger (Old alluvium). The soils are deep, loamy and high in organic matter content. The soils are very suitable for mechanized cultivation.
3. Irrigation potential is high, water table is high. Good scope of shallow tube wells.
4. The sale of tractors and power tillers during the last 10 years has increased. The survey data confirms that there are more number of tractor users than tractor owners. Custom hiring of tractors, threshers and other machinery are becoming popular.
5. Rice-Wheat cropping system is most predominant. The average rice yields in this region are between 1,900–2,100 kg/ha and that of wheat between 2,740–2,770 kg/ha. However, according to the projections of Rice-Wheat Consortium, with good management it has a potential of rice-wheat yield between 16.50 to 17.35 t/ha.
6. There is fairly good infrastructure for manufacture, sale and repair of different types of agricultural machinery.
7. The region has good climate. Predominantly there are three seasons—hot summer (April–June), hot and humid rainy season (July–October) and cool dry winter (November–March). The growing period ranges from 180–210 days in a year. Two crops are common but with irrigation, third crop can also be taken during summer.
8. The rainfall in the region is good, ranging between 1,050–1,300 mm.
9. The region has a number of ICAR Research Institutes and their Regional Stations, Agricultural Universities, Centres of All India Coordinated Research Projects, and Krishi Vigyan Kendras to support the agricultural R&D programmes including that of agricultural mechanization.
10. Region has good potential for growing fruits and vegetables.
11. The region has 2 colleges of Agricultural Engineering at Pusa (Samastipur) and Kumarganj (Faizabad) and has good number of trained personnel and experts in the field of agricultural mechanization.
12. There is a good scope of increasing production of milk, poultry and inland fisheries.
13. The region has good infrastructure of Banking System.

Weaknesses

1. The average operational holding size in 1995–96 was only 0.75 ha in Bihar and 0.86 ha in Uttar Pradesh that too was fragmented in 3–4 parcels. This makes mechanized farm operations difficult. Individual ownership of costly machines is often not economically viable.
2. The population pressure in this region is high. The population density in 2001 in Bihar was 880/km² while in Uttar Pradesh it was 689/km² as against the national average of 324/km².
3. Due to high density of population and less resources, more number of people are dependent on agriculture and the percentage of population below the poverty line in 1999–2000 in Bihar was 42.60% and in Uttar Pradesh 31.15% as against the national average of 26.10%.
4. Although there are Directorates of Agriculture, Horticulture, Fisheries and Animal Husbandry in both the States but their extension services in terms of creating awareness about new technologies, conducting field demonstrations, conducting training programmes and providing latest information to farmers are very poor. In both the States, the infrastructure and manpower for extension of agricultural mechanization programme is very poor.
5. The States do not have a clear-cut policy to encourage and promote use of tractors, power tillers and better quality of agricultural machinery for precise and timely farm operations.
6. Although about 70% of the villages are electrified, but electricity is not available for more than 10–15 hrs a day. The farmers cannot depend on electric supply for their irrigation or for operation of threshers and other stationary machines and have to depend on diesel engines.
7. In Bihar State, the funds allotted for subsidy on different types of agricultural machinery are not being utilized due to poor extension services.

Opportunities

1. By adopting precision agriculture and use of appropriate type of agricultural machinery the overall productivity can easily be increased 2–3 times.
2. The region receives good rainfall and the water table is high. By adopting proper water management practices the entire agricultural land can be converted into irrigated land. Use of

sprinkler and drip irrigation system can help in increasing water use efficiency.

3. The area has good potentiality of growing good quality fruits and vegetables. The region has also high population density. By following scientific methods of production, making best use of agricultural labour force and adopting proper Post-Harvest Technology at farm/village level, the production of horticultural crops can be increased many folds.
4. The region has good opportunity of agro-processing activities in the production catchments for increasing income and employment opportunities and reducing poverty line.
5. If greater emphasis is given on production of horticultural crops, milk, fish, poultry, etc. on scientific lines with proper infrastructural support for washing, cleaning, grading, drying, packaging, storage, cold storage, handling and transport with refrigerated vans/cool chains, the region can emerge as a big supplier of these products and can supply its produce to big markets of Delhi, Kolkata, Mumbai, Chennai etc. in addition to other cities in the region.
6. With encouragement to contract/cooperative farming on scientific lines, the production of high value crops can be increased substantially.
7. Since individual ownership of costly agricultural machinery is not economically viable due to small holdings, custom services of improved, energy efficient, high capacity precision equipment have good scope of introduction and popularization in this region. This activity should be encouraged.

Threats

1. Due to land tenancy laws, the operational holdings will be further getting smaller which will reduce the scope for agricultural mechanization.
2. In view of the diminishing contribution of agriculture sector to the State GDP, there is a danger that the future allocations for agricultural development, and more particularly for agricultural mechanization, may not get adequate priority in funds allocations and the programmes may suffer for want of adequate funds.
3. The region has good rainfall but also receives floods during monsoon. Unless proper attention is given to proper soil conservation, drainage and water management programmes, the water logging and soil erosion problems will become serious in future and it would be difficult to

maintain soil fertility.

4. In the absence of proper facilities for post harvest technology and value addition of agricultural produce, especially the perishables and semi-perishables, at farm/village level, heavy losses of these produce are going to continue in future also.
5. Unless proper facilities for quality testing are developed in the production catchments, the farmers will not be able to produce export quality items to increases export of agricultural produce.

16. LONG-TERM MECHANIZATION STRATEGIES FOR THE ZONE

For preparing long term strategies for agricultural mechanization till 2020, it is important to visualize the scenario prevailing at that time and the challenges which are to be overcome to meet the aspirations from agriculture sector. It is visualized that with the annual growth rate of about 1.8%, the population of Bihar and Uttar Pradesh in 2020 will be approximately 115.20 and 230.81 millions respectively. To be self sufficient in food grain production to have enough food for the entire population of the State @ about 200 kg/head and to have surplus for sale to deficient States or for export, the annual production of food grains in Bihar and Uttar Pradesh will have to be increased to about 23 and 70 million tonnes. This will call for increasing the productivity levels from 1,662 kg/ha to about 3,250 kg/ha in Bihar and from 2,157 kg/ha to about 3,500 kg/ha in Uttar Pradesh by 2020. Production of other items will also have to be increased in the same proportions.

16.1 Issues

By 2020, following targets will have to be met:

1. Food grain production to be increased from about 11.74 MT to 23.00 MT in Bihar (95.91%) and from 43.26 MT to about 70 MT in Uttar Pradesh (61.81% increase), at about 5% annual growth rate in Bihar and over 3% in Uttar Pradesh. The average productivity has to be increased from the present level of 1,662 kg/ha to 3,250 kg/ha in Bihar and from 2,157 kg/ha to about 3,500 kg/ha in Uttar Pradesh. Production of other items like oilseeds, horticultural crops, milk, meat, egg, fisheries will also have to be increased in the same proportions.
2. Farm power availability to be increased from present level of 0.80 kW/ha (in 2001) to about 2.5 kW/ha (212.5% increase) in Bihar and from 1.75 kW/ha to about 3.0 kW/ha (71.43% increase) in Uttar Pradesh by 2020.

3. Operational holdings will reduce from 0.75 ha in 1995–96 to about 0.50 ha in Bihar and from 0.86 ha in 1995–96 to about 0.57 ha in Uttar Pradesh in 2020, unless the land tenancy rules are revised. This will make mechanized operations more difficult.
4. The total population in Bihar is likely to increase from the present level of 82.88 million people (in 2001) to about 115.2 million people (39% increase) and in Uttar Pradesh from the present level of 160.05 million people to about 230.81 million people (39% increase) in 2020, and even if 60% people live in villages in Uttar Pradesh and 75% in Bihar, the rural population of these two States in 2020 will be approximately 69.12 million in Bihar and 138.49 million in Uttar Pradesh, which will be in excess of the present rural population of Bihar and Uttar Pradesh by 7 and 14 million people respectively. These people will also depend on agriculture, unless alternative jobs are created in other sectors.
5. Annual requirement of water for agriculture will increase substantially. The irrigated area of food grain crops in Bihar and Uttar Pradesh is not likely to increase beyond 60 and 75% by 2020 from the present level of 49.5 and 64.9% respectively. The increased production will have to be managed primarily by adopting better water management practices.
6. Recent trends show that the draught animal population in these two States is decreasing but the overall livestock population is increasing which will demand more feed and fodder to be provided in future.
7. The losses of agricultural produce specially that of horticulture, milk and fisheries are high and need to be reduced substantially to increase profitability of farmers, by adopting appropriate on-farm and village level post-harvest and value addition technologies.
8. Crops having high water requirement and comparatively low returns on investment will have to be replaced with more reliable and profitable crops through diversification of cropping systems. The selection of crops can be done in consultation with agricultural scientists and experts.
9. With the increase in crop production more surplus crop residues will be available. Its proper utilization and management for feed, fodder and energy will require greater attention.
10. For gainful employment of surplus labour force in the villages, agro-processing, agro-clinic and agro-service center facilities will have to be promoted and expanded.

16.2 What is required

1. Precision farming for timely, precise and judicious application of agricultural inputs (seed, fertilisers, water, plant protection, chemicals, agricultural machinery, etc.) for maximizing utilization efficiency of inputs, land and labour.
2. Precision land levelling and use of efficient irrigation equipment for economizing in water requirements of crops.
3. Diversification of crops suiting to water availability in the region, agro-climatic conditions and for better economic returns to the farmers. Area under cultivation of horticultural crops—fruits, vegetables, flowers and medicinal plants should be increased. Area under sugarcane should be reduced.
4. Mechanization of agricultural operations to reduce cost of operation.
5. Gradual increasing in farm power availability from the present level of 0.80 kW/ha to about 2.5 kW/ha in Bihar and 1.75 kW/ha to about 3 kW/ha in Uttar Pradesh by 2020, for timely farm operations.
6. Identification/development and promotion of high capacity, energy efficient equipment to do timely operations to reduce cost of operation and specific energy requirements.
7. Promotion of custom hiring of high capacity equipment so that marginal, small and medium categories of farmers can also take the advantage of mechanization.
8. Promotion of on-farm and village level Post-Harvest Technologies and agro-processing activities in the production catchments to reduce losses, give better returns to farmers and generate more employment opportunities.
9. Crop residue management for feed, fodder and energy. For meeting the challenges, as stated above, the long term agricultural mechanization strategies which are required for agricultural production and on-farm/village level processing, training of manpower, manufacture, sale and repair of different types of agricultural machinery, collection of reliable data regarding production and distribution of different types of agricultural machinery and monitoring the programmes

related to agricultural mechanization, are given below. It is presumed that by 2020, about 70% of the tillage, land leveling, sowing/planting, irrigation and threshing of all the important crops will be fully mechanized and other operations for different types of crops will be mechanized upto about 25–30%.

16.3 Strategies

16.3.1 Farm Power

1. This region, although highly populated, should progressively adopt to power farming for timely and precise field operations at reduced costs and to maximize utilization efficiencies of costly inputs (seed, fertilizer, plant protection chemicals, water, machinery etc.) and for conservation of natural resources—soil water and environment.
2. Availability of adequate farm power for mobile and stationary farm operations should be increased from the present level of about 0.80 kW/ha to about 2.5 kW/ha in Bihar and from 1.75 to 3.0 kW/ha in Uttar Pradesh by 2020. For stationary operations like water lifting, threshing, chaff cutting, cane crushing, cleaning, grading and other agro-processing and value addition activities, adequate electrical energy should be provided. For this it should be ensured that the farmers get at least 16–20 hours uninterrupted electrical power supply every day. If grid power availability is not assured, decentralized power generation using locally available materials should be encouraged in rural areas.

16.3.2 Improved Agricultural Implements and Machinery for Crop Production

3. Annual yield potentiality of rice–wheat cropping system of this region has been assessed, by the rice–wheat consortium, between 16.5 to 17.5 tonnes per hectare. Top priorities should be given to these crops by adopting improved varieties, high doses of fertilizers and precision equipment for proper placement of inputs. This will boost up the production of the whole region.
4. Subsoilers and equipment for deep tillage for breaking hardpan and eradication of *kans* and other perennial weeds should be introduced.
5. For timely farm operations, reduction in cost of operations and saving energy in tillage and sowing/planting/transplanting operations, large scale adoption of rotavators, conservation tillage

technologies (promotion of zero till drills, strip till drills, roto-drills, till-plant machines, raised bed planters, ridger seeder etc.) and promotion of precision drills, planters and transplanters for all crops should be promoted and given high priorities. Presently mechanization of rice transplanting and planting of sugarcane, cotton and many other crops is at very low level. Suitable machines will have to be introduced and popularized. Check row planters for cotton and other crops will have to be introduced. Electronic devices for identifying gaps and counting seeds/seedlings in planters/transplanters will be required to be introduced and popularised.

6. Power operated weeders for narrow and wider row crops will have to be introduced and popularized. High clearance tractors with narrow tyres will be required to be introduced for inter-cultural operations.
7. Aero blast sprayers, orchard sprayers and electrostatic spraying equipment will be required to be introduced for proper spraying in field and tall crops/orchards and for better deposition of chemicals.
8. Presently harvesting is done mostly by using sickles. Combines and harvesters for almost all crops. (Sorghum, pearl millets, maize, pulses, oil seeds, sugarcane, cotton, safflowers, sunflowers, castor, etc.) will have to be introduced and popularized for timely harvesting.
9. Threshing of wheat, rice, sorghum, some pulses and oil seeds crops are fairly mechanized. Threshing of other crops—pigeon pea, safflower, sunflower etc. are to be introduced and popularized. In future emphasis should be given on popularization of high capacity, energy efficient, multi-crop threshers.
10. Crops with high water requirement and comparatively low returns should be diversified with high value and high return crops as recommended by agricultural scientists and experts.
11. For increasing production and productivity more water will be required. Water management practices for conservation, storage, reducing conveyance losses through lining of channels and use of plastic pipes etc., economic application through precise land leveling and use of sprinklers and drip irrigation systems to economise in water requirement, should be given high priority.
12. For making farm ponds, bunds, farm roads,

drainage channels etc. power operated trenchers, angle dozers, drudgers, buck scrapers and other earth moving machinery will be required to be introduced on large scale.

13. In order to make efficient use of available human and animal energy, improved, efficient and ergonomically designed hand tools and matching animal operated equipment for different operations like seed bed preparation, sowing/planting, weeding/interculture etc. should be promoted and popularized.

16.3.3 Mechanization of Horticulture Crops

14. Whole set of equipment for mechanization of orchard crops—pit making, transplanting of saplings, pruning, spraying in tall crops, harvesting of fruits etc. need to be identified/imported/designed, introduced and popularized.
15. Vegetable crop production has to be mechanized for which full set of equipment from seed bed preparation, planting, transplanting of seedlings, inter culture, irrigation, spraying harvesting, picking/digging has to be identified/designed and introduced.
16. Different types of manually operated and power operated garden tools will have to be introduced and popularized for promotion of raising of seedlings for growing of fruits, vegetables and flowers and for work in the gardens.
17. Use of plastic mulch reduces water requirement and checks weed growth. Equipment for laying plastic mulch, low plastic tunnels for cultivation of vegetables, cut flowers etc. will be required to be introduced and popularised.
18. Green house technology has good scope in India for growing, seedlings, flowers, high value off-season vegetables and some fruit crops. This technology needs greater promotion. Equipment for mechanization of cultivation in green houses will be required to be introduced and popularized.

16.3.4 Feeds and Fodders

19. Equipment for harvesting of fodder crops, making sillage, feed blocks, feed pallets will be required to be introduced and popularized in future.

16.3.5 Biomass Management

20. Equipment for harvesting, retrieval, densification, fortification, handling and transport of crop residues will be required to be introduced in large numbers for making best utilization of straw and

other crop residues for feed, fodder and energy.

21. For organic farming demand of good quality manure will increase. Equipment for handling, transport and application of manure in the field in liquid and solid forms will be required. Such equipment will be required to be imported/designed and introduced on large scale.
22. Equipment for clearing of shrubs, weeds, and grasses along the roadside will be required for better look and hygiene.

16.3.6 On-farm Post Harvest Technology

23. Post harvest equipment and technology will be needed for cleaning, grading, drying, cooling, evaporative cooling, storage, cold storage and handling of farm produce to improve their quality and self-life. Cool chains for transport of perishable materials like fruits, vegetables, milk and milk products, fish, meat etc. will be required in large numbers to reduce losses.
24. Agro-processing activities should be promoted in the production catchments to reduce losses, minimize transport cost and to increase income and employment opportunities in rural areas.

16.3.7 Infrastructural Improvements

25. Testing facilities for agricultural machinery and agro-products for quality control should be created in the region and manufacturers, processors and experts should be helped in improving the quality of their products.
26. Agricultural Engineering Colleges located in this region should adequately be strengthened in their testing facilities and they should be approved for testing of certain types of agricultural machinery and quality certification of agro-products.
27. A Display Centre of Improved Agricultural Machinery be established in this region with full information and video clippings of the working of different types of equipment, from where the farmers/extension workers/policy makers etc. can get information about different types of agricultural machinery, their specifications, source of supply and cost. An experienced agricultural engineer should man this center. The center should also have the information on the improved agricultural machinery being used in other advanced countries.
28. For providing information to the farmers, information centers have been established by Department of Agriculture at some important

places. These centers are computerized and provide information on soil, crop, variety, fertilizer, chemicals, diseases and pest, irrigation requirements, loans, subsidies etc. Adequate information on the availability farm equipment, sources of supply, costs etc. are not available at these information centers. Farm machinery being a costly input to agriculture, farmers should be provided information and properly guided in selection of appropriate equipment for them. For this purpose use of IT (information technology) and kiosks centers should extensively be used. An experienced agricultural engineer should man these centers.

29. Farm machinery exhibitions and demonstrations should be organized at important places in the region every year and groups of farmers should be taken to these exhibitions to see those improved equipment and their working and to identify items which may be of interest to them.
30. Adequate facilities should be created and expanded for training of trainers, farmers, drivers/operators, mechanics, and manufacturers to support the agricultural mechanization programmes. Nationalised banks. Fertilizer companies, tractor/power tiller/combine/engine manufacturers should be involved in organizing such training programmes.
31. Training programmes should be organized for the entrepreneurs in manufacture/running of custom service centres/Agri-clinics/repair and maintenance workshops and providing contract services for different farm operations.
32. For creating awareness amongst the farmers and extension workers, regular programmes should be broadcasted/telecasted on radio and TV networks. Video films on the working of different equipment should be prepared and shown to the farmers. Front line demonstrations of new equipment should be conducted in farmer's fields and large number of farmers should be invited to see the demonstration.
33. The region has fairly good facilities for the manufacture of different types of agricultural machinery. Good manufacturers should be encouraged and given incentives to manufacture good quality equipment at competitive prices. Items to be promoted in future and their likely demand should be projected and announced in advance by the Directorates of Agriculture/Agricultural Engineering so that the manufacturers plan and make those things available to the farmers.
34. A proper mechanism should be developed to collect information, annually, about the production and sale of different types of agricultural machinery in the State, on the pattern on which crop production and yield data are being collected. This will help in getting better idea about the present trends and demand of different types of agricultural machinery and will help in better planning for the future agricultural mechanization programmes. Such data should be published annually and should be available on computer/internet.
35. To take the advantage of use of improved high capacity agricultural machinery by all categories of farmers, custom services of agricultural machinery by private entrepreneurs should be encouraged and promoted. They should be given incentives and long-term loans on concessional rate of interests. This will boost use of efficient agricultural machinery for timely farm operations at reduced cost.
36. Visit of selected groups of progressive farmers should be organized to other States/countries where they can see the modern farms and use of improved agricultural machinery. Similarly visits of selected manufacturers of the region should also be organized to progressive States and countries to see modern farms, manufacturing units and get information on different types of improved agricultural machinery. A team of Research Engineers/Scientists, manufacturers, policy makers should be sent to National/International Farm Machinery Shows to identify potential machinery for introduction in the region/State/Indian conditions for future adoption and popularization.

16.3.8 Institutional Framework

37. A Farm Mechanization Development Council, under the Chairmanship of Minister of Agriculture be setup at the State level to plan, guide, review and monitor the programmes related to agricultural mechanization in the State. This council should be represented by the officials of the Deptt. of Agriculture, Agricultural Engineering, Animal Husbandry, Horticulture, Fisheries, Irrigation, industries, manufacturers of agricultural machinery, leading banks, Agro industries Corporation, State Planning

Commission, ICAR Institute in the region, State Agricultural University and Progressive farmers. This council should meet twice a year.

38. The existing infrastructure and manpower for identification, planning, execution, guidance and monitoring of agricultural mechanization and agro-processing activities in the State is poor and inadequate. There is a strong need for creating a separate Directorate of Agricultural Engineering in the State to plan, execute, review, and monitor various programmes related to agricultural mechanization and post harvest activities in the State. A Monitoring Cell should also be established in the Directorate of agriculture/ Agricultural Engineering for this purpose. This Cell should maintain computerized databases and progress reports of all the programmes.

16.3.9 Policy Issues

39. To encourage agricultural mechanization on sound footing there should be a State Policy for agricultural mechanization.
40. In order to encourage use of energy efficient equipment, the farmers should not be provided free electricity. Rather the electricity should be provided to them at subsidized rates and they should be given incentives in the support price of food grains.
41. To encourage the owner of farm machinery to insure their farm equipment and to provide an insurance cover to the farm labour, group insurance scheme for equipment like tractors, power tillers combines threshers etc. should be started and the premium rate should be 0.5% or less of the machine value insured.

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